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SCHEINBERG & GRINER, LLP
P. O. Box 164140
Austin, Texas 78716-4140
Telephone: (512) 637-0800
Facsimile: (512) 306-1963

MICHAEL O. SCHEINBERG
mscheinberg@sgnlaw.com

DAVID GRINER
dgriner@sgnlaw.com

January 11, 2008

Fax

Name:	Examiner Olsen
Art Unit:	1763
Organization:	United States Patent and Trademark Office
Fax:	1-571-273-8300
From:	David Griner P.O. Box 164140 Austin, TX 78716-4140
Phone:	(512) 637-0800
Fax:	(512) 306-1963
Date:	July 30, 2007
Subject:	Amended Appeal Brief
Docket No.:	F125
Pages:	28 pages *(including this coversheet)*

APPLICATION No.:	10/758,966	ART UNIT:	1763
FILING DATE:	January 16, 2004	EXAMINER:	Allan W. Olsen
INVENTOR(S):	Diane K. Stewart et al.		
TITLE:	Electron Beam Processing for Mask Repair		

In connection with the above-identified patent application, applicants submit the following:

1. Amended Appeal Brief (27 pp.)

David Griner
Patent Reg. No.: 47,614

As first transmission was incomplete, Applicants hereby resubmitt the Amended Appeal Brief.

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Attorney Docket No. F125

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Board of Patent Appeals and Interferences

Applicants: Diane K. Stewart, J. David Casey, Jr., John Beaty, Christian R. Musil, Steven Berger and Sybren J. Sijbrandij

App. No.: 10/758,966

Filing Date: 01/16/2004

Title: Electron Beam Processing for Mask Repair

Examiner: Allan W. Olsen

Art Unit: 1763

AMENDED APPEAL BRIEF

In accordance with 37 C.F.R. 41.37, Appellant hereby submits this brief in furtherance of the Notice of Appeal, filed in this case on July 30, 2007, and received by the U.S. Patent and Trademark Office on July 30, 2007. This brief has been amended to comply with the December 13, 2007, Notification of Non-Compliant Appeal Brief.

CERTIFICATE OF TRANSMISSION UNDER 37 C.F.R. 1.8

I hereby certify that this correspondence is being facsimile transmitted to the United States Patent and Trademark Office, on the date shown below.

On: January 11, 2008
By: Elizabeth Bell
Name: Elizabeth Bell
Telephone Number: (512) 637-0800

Attorney Docket No.: F125

Table of Contents

I. Real Party in Interest

The real party in interest in this appeal is:

FEI Company, an Oregon Corporation having its principal place of business in Hillsboro, Oregon.

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II. Related Appeals and Interferences

There are no prior or other pending appeals, judicial proceedings, or interferences known to appellant which may be related to, directly affect, or be directly affected by, or have a bearing on the Board's decision in this appeal.

Attorney Docket No.: F125

III. Status of Claims

A. Total Number of Claims in Application

There are a total of 14 claims in the application.

B. Status of All the Claims

1. Claims canceled: 13-20
2. Claims withdrawn from consideration but not canceled: NONE
3. Claims pending: Claims 1-12 and 21-22
4. Claims allowed: NONE
5. Claims rejected: 1-12, 21-22

C. Claims on Appeal

The claims on appeal are: 1-12, 21-22

IV. Status of Amendments

Appellants filed an amendment to the claims subsequent to final rejection. This amendment canceled claims 13-20 and rewrote claims 21 and 22 to incorporate the limitations of their canceled parent claims. This amendment was allowed by the Examiner in the June 19, 2007, Advisory Action Before the Filing of an Appeal Brief.

V. Summary of Claimed Subject Matter

Applicants' claims 1, 21, and 22 are in independent form.

The present invention provides methods of restoring transparency to a substrate having reduced light transmission, for example, from gallium atoms incidentally implanted by a focused ion beam used to remove material. Defects in photolithography masks are often repaired using focused beams of gallium ions. Unfortunately, the ion beam also damages the mask surface and implants gallium ions into the substrate, thereby reducing the transmission of light and adversely affecting the performance of the mask. (Specification, p. 2, lines 10-17.) The transparency of the mask can be restored by etching away the implanted quartz, however removing the implanted material changes the thickness of the substrate which in turn changes the phase of the transmitted light. This also adversely affects the performance of the mask. (Specification, p. 2, lines 18-23; p. 3, lines 1-2.)

Applicants have found that the transparency of the repaired area can be restored by directing an electron beam in the presence of an etch-enhancing gas toward the repaired area at a beam energy and dose such that the thickness of the substrate is not substantially decreased by the electron beam bombardment. (Specification, p. 3, lines 10-18; p. 6, lines 3-23; p. 7, lines 1-7.) Especially where the implanted gallium is at a relatively high concentration, applicants have found that the transparency of the repaired area can be restored without a substantial change in the substrate thickness. (Specification, p. 6, lines 7-9.) While the substrate thickness, and therefore the phase of the transmitted light, is substantially unchanged, the transparency of the repaired area is increased, typically to greater than 90% or 95%. (Specification, p. 6, lines 10-12.) By maintaining a thickness close to that of the original mask, the effect of the mask repair on the phase of the transmitted radiation is minimized. (Specification, p. 3, lines 15-17.)

Applicants' independent claim 1 recites restoring the transparency of a quartz material having implanted gallium by directing a gas towards a gallium implanted portion of the quartz material and directing an electron beam towards the gallium implanted portion of the quartz material, the electron dose of the electron beam being such that the thickness of the quartz material is substantially unchanged, and the transmission of the quartz material is substantially increased. (Specification, p. 6, lines 3-17.)

Dependent claim 4 recites that the transmission is increased to greater than 80% of the transmission of the quartz material without implanted gallium. And claim 5 recites that the transmission is increased to greater than 90% of the transmission of the quartz material without implanted gallium. (Specification, p. 13, lines 18-19.)

Dependent claims 6-8 recite that the thickness of the quartz material changes by less than 2 nm, 5 nm, and 10 nm, respectively. (Specification, p. 13, lines 22-23; p. 14, lines 1-2.) Dependent claim 8 requires that the thickness of the quartz material changes by less than 10 nm while the transmission is increased to greater than 90% of the transmission of the quartz material without implanted gallium. (Specification, p. 13, lines 18-23; p. 14, lines 1-2.)

Dependent claim 10 provides that the electron dose directed at the quartz material is less than 2.0 nC/μm^2. (Specification, p. 18, lines 10-11; FIGS. 1-5.) Dependent claim 11 provides that the electron dose be between about 0.1 nC/μm^2 and about 1.0 nC/μm^2. (Specification, p. 12, lines 19-22.) And Dependent claim 12 provides that the electron dose be between about 0.4 nC/μm^2 and about 0.8 nC/μm^2. (Specification, p. 7, lines 8-23; p. 8, lines 1-23; p. 9, lines 2-15.)

Independent claim 21 is directed at restoring the transparency to 90% the transparency without the implanted material while etching the substrate by less than 5 nm. (Specification, p. 13, lines 18-23; p. 14, lines 1-2.)

Independent claim 22 is directed at increasing the transparency of the implanted substrate while etching the substrate by less than 5 nm. (Specification, p. 13, lines 22-23; p. 14, lines 1-2.)

VI. Grounds of Rejection to be Reviewed on Appeal

A. First Issue

Whether claims 1-3, 6-8, 10-12, 21 and 22 are unpatentable under 35 U.S.C. § 102(e) as anticipated by Musil.

B. Second Issue

Whether claims 1-12, 21, and 22 are unpatentable under 35 U.S.C. § 102(e) as anticipated by Stewart.

C. Third Issue

Whether the Examiner used the wrong standard to determine anticipation under § 102.

VII. Argument

A. Whether claims 1-3, 6-8, 10-12, 21 and 22 are unpatentable under 35 U.S.C. § 102(e) as anticipated by Musil.

Claims 1-3, 6-8, and 10-12 are rejected under 35 USC § 102(e) as anticipated by U.S. Patent Application Publication 2003/0047691 of Musil et al. (hereinafter "Musil"). A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference. *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987); see M.P.E.P. § 2131. Applicant submits that the reference cited by the Examiner does not set forth, either expressly or inherently, all of the elements of the rejected claims. All of the rejected claims do not stand or fall together. Independent claims 1, 21, and 22 contain different claim language that requires them to be considered separately. Also, as discussed below, dependent claims 4-5, 9, and 10-12 contain additional limitations that make them separately patentable.

Claim 1

Applicants' claim 1 (along with dependent claims 2-3, 6-8, and 10-12) claims "[a] method of restoring the transparency of a quartz material having implanted gallium that reduces the transmission of the quartz material, comprising: directing a gas towards a gallium implanted portion of the quartz material; and directing an electron beam towards the gallium implanted portion of the quartz material, the electron dose of the electron beam being such that the thickness of the quartz material is substantially unchanged, and the transmission of the quartz material is substantially increased." (emphasis added.)

The Musil reference simply does not teach all of the limitations found in this claim.

Instead of a method of restoring the transmission of a quartz-implanted substrate like the one described and claimed by Applicants, the Musil reference teaches methods of removing opaque defects, such as a spot of chromium on top of the quartz substrate. Musil teaches electron beam etching instead of ion beam etching so that the defect can be removed without damaging the quartz substrate. Musil does not teach any method at all for restoring or even improving the transmission of an implanted quartz substrate. The only mention of a repair involving implanted quartz in the reference is found in a suggestion that an ion beam can be used to remove most of the opaque defect and an electron beam used to remove the final 20-40 nm of material. According to the reference,

> "By removing most of the defect layer using the focused ion beam, the defect is removed more quickly because the etch rate of the ion beam is typically greater than that of the electron beam. The gallium atoms from the focused ion beam typically implant in the target to a depth of between 20-40 nm. By leaving approximately that thickness of material unetched by the ion beam and then using the electron beam to remove the remaining material, <u>little or no gallium will be implanted into the mask itself</u>."

Musil, at col. 7, lines 37-45 (emphasis added).

Instead of a defect that is repaired, this gallium implantation is merely a possible by-product of the opaque defect repair process taught by Musil. Thus, Musil does not teach "restoring the transparency of a quartz material having implanted gallium" or "restoring the transparency of a transparent substrate having an implanted material" as required by Applicants' claims. Musil only teaches removal of an opaque layer on top of the quartz. As a part of one described removal process, the reference admits a possibility that some small degree of gallium implantation will occur. However, the whole point of the method taught by Musil is to avoid

gallium implantation. The reference says nothing about repairing implantation or restoring the transparency of an implanted layer, if any gallium implantation should occur.

The Examiner states that "Musil teaches repairing opaque defects of a lithography mask by directing an electron beam and XeF2 toward a region of a quartz substrate into which Ga+ ions have been implanted." Final Office Action, p. 5. In the response to Applicant's original argument on this point, the Examiner stated "Further, the examiner considers a metal coated quartz substrate to be opaque (i.e., non-transparent). Therefore a process that repairs an opaque defect on a quartz substrate is considered to be a process that restores transparency to the quartz substrate." The Examiner's comments make it clear that the Examiner is misinterpreting the plain language in Applicants' claims. Removing an opaque defect may affect the transparency of the entire photomask; however it does not increase the transmission of the quartz material as required by Applicants' claims. The claim language specifically addresses the transmission of the quartz layer itself. An opaque defect on top of the quartz layer would not be part of the quartz layer itself and removal of such an opaque layer would not affect the transmission of the quartz.

While Applicants recognize that during patent examination, pending claims must be given their broadest reasonable interpretation consistent with the specification, the Examiner's interpretation is both unreasonable and inconsistent with the plain language in the claims and Applicants' specification. The Examiner is not allowed to ignore the plain language in the claims, and Applicants' claims 1-3, 6-8, 10-12 specifically require that the transmission of the quartz material itself be increased. Further, the Examiner's interpretation is completely inconsistent with Applicants' Specification, which makes it absolutely clear that Applicants' claims are directed at increasing the transmission of the quartz-implanted material itself, rather

than increasing overall transmission by milling away opaque material covering the quartz-implanted material.

Further, even if the term "quartz layer" could be interpreted to include the opaque defect, Musil would still not teach all of the limitations of Applicants' claims 1-3, 6-8, 10-12. Applicants' claim 1 (along with dependent claims 2-3, 6-8, 10-12) requires that the transmission of the quartz material be substantially increased while the thickness of the quartz material is substantially unchanged. In Musil, the electron beam is used to completely remove the material causing opaque defects. If the "quartz layer" is defined to include the opaque defect, the reference does not teach improving the transmission of a substrate while the substrate thickness is substantially unchanged because the entire defect layer is removed in Musil.

Also, even if the Examiner's interpretation of restoring transmission is accepted, Musil fails to teach "directing an electron beam towards the gallium implanted portion of the quartz material" as required by Applicants' claims. As admitted by the Examiner in the most recent Office communication of June 19, 2007, Musil teaches removing the last 20-40 nm of the opaque defect with an electron beam but "[t]his electron beam etching does not etch the transparent quartz substrate." (emphasis in original). This is because Musil teaches directing the gas and the electron beam <u>at the defect material</u>, not at the quartz substrate.

<u>**Claims 4-5 and 9**</u>

In addition to the limitations of independent claim 1, claim 4 requires that the "the transmission is increased to greater than 80% of the transmission of the quartz material without implanted gallium." Claim 5 and 9 require that the transmission be increased to greater than 90% of the transmission of the quartz material (or substrate) without implanted gallium. Even if

removing an opaque defect as taught by Musil satisfies the requirement of increasing transmission of the quartz layer, Musil says nothing about increasing the transmission levels beyond any certain percentage as compared to the quartz material without implanted gallium. Because Musil does not teach any method whatsoever of repairing gallium implantation, after the opaque defect is removed, the transparency of the substrate will depend upon the original degree of gallium implantation. A claim limitation is inherent in the prior art only if it is <u>necessarily</u> present in the prior art, not merely probably or possibly present. *Rosco v. Mirror Lite*, 304 F.3d 1373, 1380, 64 USPQ2d 1676 (Fed. Cir. 2002) (emphasis added). In other words, the exact limitations in Applicants' claims must be expressly or necessarily present in the reference. Here, Musil says nothing about the transparency of the implanted quartz. Depending upon the degree of original gallium implantation, the transparency could be greater than 80 % or 90% of the transparency without the implanted material or it could be less. Whatever the degree of original gallium implantation, it will be unchanged by the repair process since Musil does not teach a method of repairing gallium implantation. As a result, this limitation in claims 4-5 and 9 is not taught by Musil.

Applicants also note that this limitation makes little sense if the claims are interpreted as suggested by the Examiner. This further illustrates that the Examiner's interpretation is unreasonable and that no person of ordinary skill would interpret the claims as the Examiner has.

<u>**Claims 10-12**</u>

Claims 10-12 also contain limitations describing the electron beam dose to be provided to the implanted quartz material. Claim 10 requires providing an electron dose of less than 2.0 nC/μm2; claim 11, a dose between about 0.1 nC/μm2 and about 1.0 nC/μm2; and claim 12, a

dose of between about 0.4 nC/μm2 and about 0.8 nC/μm2. These limitations are simply not found in the Musil reference. For claims 10-12, the Examiner does make the statement that because Musil obtains results that meet the result-limitations in the claims, it follows that "comparable" operational parameters were used in Musil. First, Applicants note that Musil does not achieve the same results as the methods in the rejected claims. Musil teaches a method of removing an opaque defect on top of a quartz layer. The claims at issue are directed at increasing the transmission of implanted quartz. Even if both are considered to be methods of increasing quartz transmission, they are still different repair methods directed at different types of defects.

"Comparable" limitations are simply not enough to establish § 102 anticipation. Each limitation in an anticipated claim must be expressly or inherently present in the reference. There is nothing in the reference describing electron beam doses within the ranges specified by Applicants' claims, and the Examiner has provided no explanation as to why such ranges are inherent in the reference.

Further, Applicants' specification notes that the electron beam doses used in the rejected claims result in little or no etching of the substrate. Specification, p. 7, lines 17-23. In contrast, Musil is directed at a method of intentionally etching away a part of the substrate. Because Musil teaches methods of deliberate substrate etching using electron beams, and because Applicants' the beam doses in the rejected claims result in little or no substrate etching, Musil actually teaches away from using the electron beam doses required by the rejected claims.

Claims 21 and 22

The Musil reference also does not teach all of the limitations found in claims 21 and 22.

Both claims are directed at a "method of restoring the transparency of a transparent substrate having an implanted material that reduces the transmission of the sububstrate." As was the case for claim 1 above, Musil does not teach restoring the transparency of the substrate.

Because claims 21-22 use the word "substrate" instead of the phrase "quartz layer," the Examiner's interpretation of the term "substrate" as including the opaque defect might be more reasonable for these claims than for the claims discussed above. However, claims 21 and 22 also includes the limitation that the substrate is etched by less than 5 nm. As discussed above, the only mention of a repair involving implanted quartz in the reference is found in a suggestion that an ion beam can be used to remove most of the opaque defect (which might possibly result in some gallium implantation) and an electron beam used to remove the final 20-40 nm of opaque material. And if the opaque defect is included within the interpretation of "substrate" for the purpose of the limitation "increasing the transparency of the substrate," it would also have to be included within the interpretation of the term for the limitation "etching the substrate by less than 5 nm." Obviously, removing 20-40 nm of material would not satisfy the limitation that the substrate is etched by less than 5 nm.

Claims 9 and 21

Claim 21 also contains the additional limitation that the transparency of the substrate be restores to greater than 90% of the transparency without the implanted material. The same limitation is also found in claim 9. As discussed above, Musil does not teach any method whatsoever of repairing the gallium implantation. After the opaque defect is removed, the transparency of the substrate will depend upon the degree of gallium implantation which has occurred. A claim limitation is inherent in the prior art only if it is <u>necessarily</u> present in the

prior art, not merely probably or possibly present. *Rosco v. Mirror Lite*, 304 F.3d 1373, 1380, 64 USPQ2d 1676 (Fed. Cir. 2002) (emphasis added). In other words, the exact limitations in Applicants' claims must be expressly or necessarily present in the reference. Here, Musil says nothing about the transparency of the implanted quartz. It could be greater than 90% of the transparency without the implanted material or it could be less. As a result, this limitation is not taught by Musil.

B. Whether claims 1-12, 21, and 22 are unpatentable under 35 U.S.C. § 102(e) as anticipated by Stewart.

Claims 1-12 and 21-22 are also rejected under 35 USC § 102(e) as anticipated by U.S. Patent Application Publication 2004/0151991 of Stewart et al. (hereinafter "Stewart"). Applicant submits that the reference cited by the Examiner does not set forth, either expressly or inherently, all of the elements of the rejected claims. All of the rejected claims do not stand or fall together. Claims 1, 10-12, and claims 21 and 22 contain different claim language that requires them to be considered separately. Also, as discussed below, dependent claims 2-3, 6-8, and 10-12 contain additional limitations that make them separately patentable.

The Examiner initially notes that Stewart incorporates Musil by reference. To the extent that the anticipation rejection is based upon incorporation of the Musil reference, the claims would be allowable for the reasons discussed above.

The Stewart reference itself also fails to anticipate any of Applicant's claims. All of the rejected claims require that the transparency of the quartz material (or substrate) be restored while the thickness of the quartz material is either substantially unchanged (claims 1-12) or etched by less than 5 nm (claims 21-22). While Stewart does address restoring the transmission

of gallium-implanted quartz layer, the layer is repaired by removing the implanted quartz using electron beam assisted etching. See, e.g., Stewart at [0036] and [0044]. Obviously, removal of the gallium-implanted quartz would substantially change the thickness of the layer. Nowhere does Stewart mention increasing the transmission of the implanted quartz material without substantially changing the thickness of the layer or by etching the substrate less than 5 nm.

In fact, in each of the office actions in this case, the Examiner has actually quoted language in Stewart making it clear that the transmission is restored by <u>removing the implanted quartz material</u>. For example, the following quotation is taken directly from the Final Office Action:

> Additionally, Stewart teaches (with emphasis added):
>
> '[0036] Mask repair can use both electron beam and ion beam etching and deposition. In embodiments in which it is not desired to use ion implantation staining, an electron beam repair is preferred because it eliminates ion implantation. For example, MoSi and TaN.sub.2 absorber material can be etched using an electron beam and an etchant gas, such as XeF.sub.2, as described in **U.S. patent application Ser. No. 10/206,843 for "Electron Beam Processing," by Musil et al., which is hereby incorporated by reference.** The gallium beam can be also be used for etching chrome, and **the gallium-implanted layer can be removed using the gas assisted etching using the ion beam or an electron beam.'**
>
> '[0038] A strategy to repair a particular defect can include multiple stages, using combinations of ion, electron or lasers. For example, **an ion beam can be used to remove an opaque defect and then an electron beam can be used to etch a layer of gallium-implanted quartz using XeF.sub.2 as post processing to <u>restore</u> transmission.'**
>
> [0044] In accordance with various repair strategies that can be used, a work piece can be processed using an electron beam or an ion beam. The effects of **ion implantation can be:** 1. avoided by using an electron beam for some operations; 2. used constructively to provide desired optical properties; or 3. **eliminated by removal of the implanted layer.** Multi-stage operations that use a combination of laser beams, ion beams, and electron beams can speed operations and reduce defects. For example, **an ion beam can be used to process a defect and then an electron beam can be used to remove the effects of the ion beam.**

Final Office Action of Feb. 28, 2007, at p. 6 (emphasis in original).

The Examiner has curiously maintained the anticipation rejection based upon Stewart despite the fact that the quoted language (as emphasized in bold by the Examiner) clearly shows that not only does Stewart fail to teach the limitation of restoring transmission of the quartz layer without substantially changing the thickness of the layer, the reference actually teaches the opposite by teaching that the implanted quartz is completely removed.

C. Whether the Examiner used the wrong standard to determine anticipation under § 102.

It appears to Applicants that the Examiner is using the wrong standard to evaluate anticipation under § 102. For example, the Examiner expressly acknowledges that Musil does not explicitly teach the limitations of claims 6-8, 10-12, and 21-22 (Final Office Action of Feb. 28, 2007, at p. 5) but nevertheless still rejects these claims under § 102. According to the Examiner, because Musil obtains results that meet the result-limitations in the claims, it follows that "comparable" operation parameters were used in Musil. "Comparable" limitations, however, are not enough to show § 102 anticipation.

Further, as discussed above, the Examiner continues to maintain an anticipation rejection based upon the Stewart reference, despite the fact that the very language quoted and emphasized by the Examiner in the various Office Actions clearly shows that Stewart does not teach all of the limitations in the rejected claims.

With all due respect, it appears that the Examiner has based his rejections upon his interpretation of the "gist" or "thrust" of the application, rather than an examination of the actual claimed invention. *See Bausch & Lomb v. Barnes-Hind/Hydrocurve, Inc.*, 796 F.2d 443, 447-49, 230 USPQ 416, 419-20 (Fed. Cir. 1986), *cert. denied*, 484 U.S. 823 (1987) (District court erred

by focusing on "concept of forming ridgeless depressions having smooth rounded edges using a laser beam to vaporize the material" while disregarding express limitations in claims); *see also* MPEP § 2142.02(II). Because Musil and Stewart also teach methods of repairing transmission defects using an electron beam and etching gas, the Examiner has concluded that these references anticipate the present invention without considering the express limitations in Applicants' claims. This is simply not the standard for § 102 anticipation.

As a result, Applicants submit that the § 102 rejection of claims 1-12 and 21-22 is improper. It may well be that Musil and/or Stewart render Applicants' claims <u>obvious</u> under § 103. In fact, it does appear that the all of the Examiner's reasons for rejecting Applicants' claims would be much more appropriate for a § 103(a) rejection. However, because the subject matter of Musil, Stewart, and the claimed invention were, at the time the claimed invention was made, owned by FEI Company, the assignee of the present invention, neither reference can be used to render the present invention obvious under § 103(a).

CONCLUSION

Appellants have demonstrated that claims 1-3, 6-8, 10-12, 21 and 22 are not anticipated by Musil. Appellants have also demonstrated that claims 1-21 and 21-22 are not anticipated by Stewart. Finally, Appellants have demonstrated that the Examiner applied an incorrect standard to determine whether claims at issue were anticipated under 35 U.S.C. § 102. Accordingly, it is respectfully requested that the Board reverse these rejections allow the application to issue.

Respectfully submitted,

Date: January 11, 2008

By: David Griner

David Griner
Pat. Reg. No. 47,614
P.O. Box 164140
Austin, TX 78716-4140
Tel: (512) 637-0800
Fax: (512) 306-1963

Attorney Docket No.: F125

VIII. Claims Appendix

1. (rejected) A method of restoring the transparency of a quartz material having implanted gallium that reduces the transmission of the quartz material, comprising:

directing a gas towards a gallium implanted portion of the quartz material; and

directing an electron beam towards the gallium implanted portion of the quartz material, the electron dose of the electron beam being such that the thickness of the quartz material is substantially unchanged, and the transmission of the quartz material is substantially increased.

2. (rejected) The method of claim 1 in which directing a gas towards the portion of the quartz material includes directing a gas comprising a halogen compound.

3. (rejected) The method of claim 2 in which directing a gas towards the portion of the quartz material includes directing a gas comprising xenon difluoride.

4. (rejected) The method of claim 1 in which directing an electron beam towards a portion of the quartz material includes directing an electron beam towards a portion of the quartz material such that the transmission is increased to greater than 80% of the transmission of the quartz material without implanted gallium.

5. (rejected) The method of claim 1 in which directing an electron beam towards a portion of the quartz material includes directing an electron beam toward a portion of the quartz material such that the transmission is increased to greater than 90% of the transmission of the quartz material without implanted gallium.

6. (rejected) The method of claim 1 in which directing an electron beam toward a portion of the quartz material includes directing an electron beam toward a portion of the quartz material such that the thickness of the quartz material changes by less than 2 nm.

7. (rejected) The method of claim 1 in which directing an electron beam toward a portion of the quartz material includes directing an electron beam toward a portion of the quartz material such that the thickness of the quartz material changes by less than 5 nm.

8. (rejected) The method of claim 1 in which directing an electron beam toward a portion of the quartz material includes directing an electron beam toward a portion of the quartz material such that the thickness of the quartz material changes by less than 10 nm.

9. (rejected) The method of claim 8 in which includes directing an electron beam toward a portion of the quartz material such that the transmission is increased to greater than 90% of the transmission of the quartz material without implanted gallium.

10. (rejected) The method of claim 1 in which directing an electron beam towards a portion of the quartz material includes providing an electron dose of less than 2.0 $nC/\mu m^2$.

11. (rejected) The method of claim 10 in which directing an electron beam toward a portion of the quartz material includes providing an electron dose of between about 0.1 $nC/\mu m^2$ and about 1.0 $nC/\mu m^2$.

12. (rejected) The method of claim 11 in which directing an electron beam toward a portion of the quartz material includes providing an electron dose of between about 0.4 $nC/\mu m^2$ and about 0.8 $nC/\mu m^2$.

Claims 13-20 canceled.

21. (rejected) A method of restoring the transparency of a transparent substrate having an implanted material that reduces the transmission of the substrate, comprising:

providing a gas at the surface of a substrate; and

directing an electron beam toward the substrate, the electron beam, the gas and the substrate interacting to increase the transparency to the substrate, in which directing said electron

beam toward the substrate includes restoring the transparency of the substrate to greater than 90% of the transparency without the implanted material, and etching the substrate by less than 5 nm.

22. (rejected) A method of restoring the transparency of a transparent substrate having an implanted material that reduces the transmission of the substrate, comprising:

providing a gas at the surface of a substrate; and

directing an electron beam toward the substrate, the electron beam, the gas and the substrate interacting to increase the transparency to the substrate, in which directing an electron beam toward the substrate includes etching the substrate by less than 5 nm.

IX. Evidence Appendix

None

Attorney Docket No.: F125

X. Related Proceedings Appendix

None